

EMBRYOLOGY OF *ERYTHRINA CAFFRA* THUNB.: SPOROGENESIS AND GAMETOGENESIS

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ABSTRACT

Microsporogenesis takes place in tetrasporangiate anthers. Microspore tetrads are tetrahedral. The tri-porate microspores are two-celled at the time of shedding. Ovules are bitegmic and crassinucellate. The megaspore tetrads are typically linear and development of the female gametophyte is of the *Polygonum*-type.

UITTREKSEL

EMBRIOLOGIE VAN *ERYTHRINA CAFFRA* THUNB: SPOROGENESE EN GAMETOGENESE

Mikrosporogenese vind in tetrasporangiate helmknoppe plaas. Mikrospoortetrades is tetraëdraal. Die mikrospore besit drie porië en is met vrystelling tweesellig. Saadknoppe besit elk twee integumente en is krassinusellêr. Die megaspoortetrades is tipies liniêr en die ontwikkeling van die vroulike gametofiet vind volgens die *Polygonum*-tipe plaas.

INTRODUCTION

Erythrina caffra, an indigenous papilionaceous tree, is distributed along the coastal districts of the eastern Cape Province, the lower Natal south coast and Zululand (Hennessy, 1972). Its occurrence in the Alexandria forest is frequent and some specimens attain heights of 18 to 20 metres (Batten & Bokelmann, 1966; Hennessy, 1972). *E. caffra* is commonly cultivated in gardens and parks. Despite its recognition as an ornamental, *E. caffra* has been botanically neglected. This paper deals with an investigation of its sporogenesis and gametogenesis. The embryology of *E. caffra* has not yet been described, although a similar study has been conducted on *E. indica* (syn. *E. variegata* var. *orientalis*) by Chandravada (1963).

MATERIAL AND METHODS

The material for this study was collected from a tree on the Bird Street Campus of the University of Port Elizabeth. Anthers and ovaries were fixed in Craib II (Sass, 1958). Dehydration was carried out in an ethyl alcohol/tertiary butyl alcohol series. The tissue was embedded in paraffin wax (55°C) and sectioned at 10 μ m on a rotary microtome as prescribed by Brooks, Bradley and Anderson (1950). Staining materials included safranin-fast green (Holtzhausen, 1972) as well as safranin-haematoxylin (Brooks *et al.*, 1950).

Accepted for publication 21st July, 1976.

RESULTS AND DISCUSSION

The anther

Initially the anther of *E. caffra* consists of a mass of uniform meristematic cells surrounded by an epidermis. Eventually four pollen sacs become evident (Fig. 1) and as the anther matures the septum in each lobe breaks down.

The anther has a distinct and persistent epidermis (Fig. 1), which remains simple and uniseriate. Below this is the endothecium, easily recognisable because of its horseshoe-shaped fibrous thickenings (Fig. 1). Surrounding the sporogenous cells are the uninucleate cells of the tapetum. These are of the glandular or secretory type as defined by Maheshwari (1950). Between the endothecium and the tapetum are one to three middle layers. These are ephemeral and in later development of the anther, appear somewhat obliterated.

Microsporogenesis

The primary sporogenous cells, after mitotic divisions, give rise to the microspore mother cells (Fig. 2). These then divide meiotically to produce microspore tetrads. Microsporogenesis occurs simultaneously and the tetrads are typically tetrahedral (Fig. 3). Each tetrad is enveloped by a thick callose layer.

Microgametogenesis

The pollen grains of *E. indica* are reported to be more or less spherical and typically triporate (Chandravadana, 1963). Those of *E. caffra* resemble this closely (Fig. 4). The exine is conspicuous and characteristically thickened. According to Davis (1966) the pollen grains of papilionaceous legumes may have two or three nuclei by the time they are shed. In *E. indica*, Chandravada (1963) reports the presence of two nuclei. Pollen grains of *E. caffra* are also two-celled at the time of shedding.

The ovule

The short-stalked ovule of *E. caffra* is campylotropous and bitegmic (Fig. 5). At the megaspore mother cell stage the outer integument alone forms the micropyle (Fig. 6). However, by the time the embryo-sac is mature, the inner integument also participates in micropyle formation. In *E. indica*, the bitegmic condition also exists and both integuments are responsible for the formation of the micropyle. (Chandravadana, 1963).

While the ovule is still young the inner integument is two cell layers thick and the outer integument consists of three cell layers (Fig. 6). Later, however, the outer integument becomes multiseriate.

At the micropyle is a "plug" of tissue inserted between the lips of the outer integument (Fig. 5). This is an extension of the inner integument and seems to answer to the description of an operculum (Kapil & Vasil, 1963).

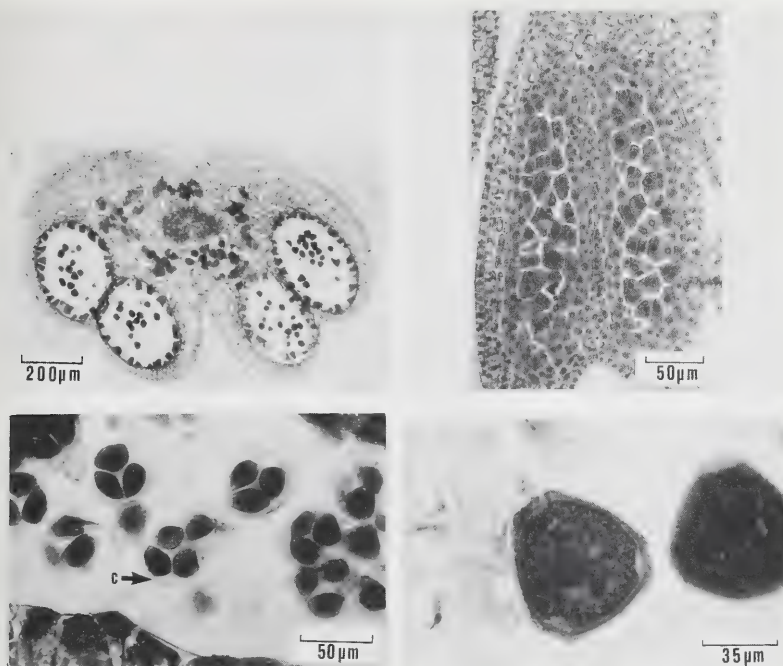


FIG. 1.

A transverse section through an anther showing the four sporangia.

FIG. 2.

Longitudinal section through a young anther showing microspore mother cells.

FIG. 3.

Microspore tetrads with typical tetrahedral disposition (c = callose layer).

FIG. 4.

A triporate pollen grain of *E. caffra*.

The megaspore mother cell of *E. caffra* is separated from the nucellar epidermis by a layer of cells and is also flanked by parietal tissue (Fig. 6). According to the definitions of Maheshwari (1950) and Eames (1961), ovules of this type are crassinucellate.

The vascular supply of the ovule consists of a single funicular bundle which terminates in the chalazal region.

Megasporogenesis

The megaspore mother cell (Fig. 6) undergoes meiosis. After the first division a dyad is formed (Fig. 7) and the two nuclei are separated by a transverse wall. As a result of the second division a tetrad forms (Fig. 8). In *E. caffra* the tetrads are typically linear, although T-shaped tetrads were also observed. The three megaspores at the micropylar end degenerate, leaving only the chalazal megaspore to function and eventually give rise to the embryo-sac (Fig. 8).

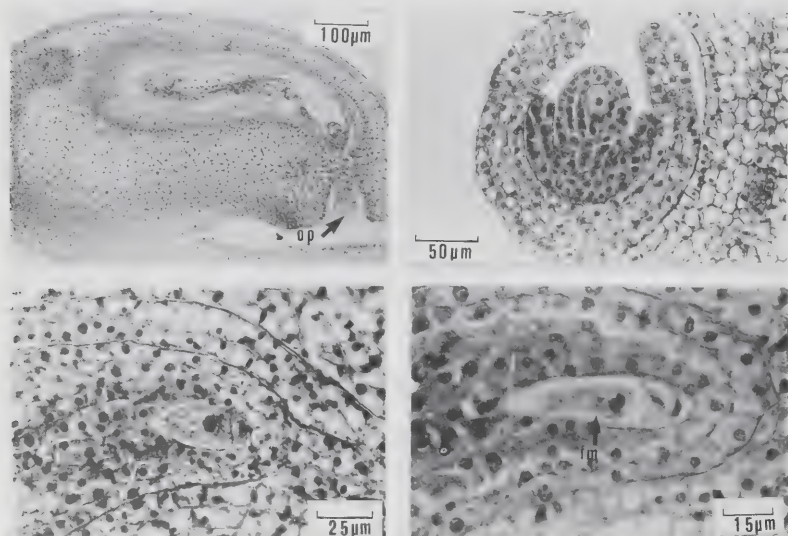


FIG. 5.

A longitudinal section through the campylotropous ovule (op = operculum).

FIG. 6.

A transverse section of the bitegmic, crassinucellate ovule showing the megaspore mother cell.

FIG. 7.

The megaspore dyad after the first division of the mother cell.

FIG. 8.

A tetrad showing two degenerating micropylar megaspores and the single functional megaspore (fm) at the chalazal end.

Megagametogenesis

The functional megaspore (Fig. 8) enlarges and then divides mitotically to form two nuclei which migrate to opposite poles of the embryo-sac (Fig. 9). Each of these nuclei divides again to produce a four-nucleate embryo-sac (Fig. 10a & b). After a third division the elongated embryo-sac contains eight nuclei. Four of

these, aggregated at the micropylar end, constitute the three-celled egg apparatus (Fig. 11a & b) and one of the polar nuclei. The four chalazal nuclei differentiate to form the second polar nucleus and the three antipodals. The two spherical polar nuclei are equal in size and shape and fuse prior to fertilization to form the primary endosperm nucleus (Fig. 11a & b).

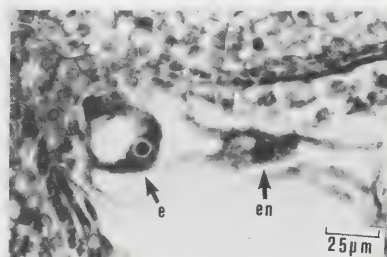
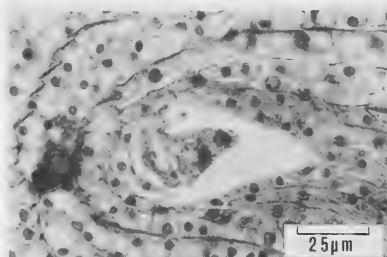
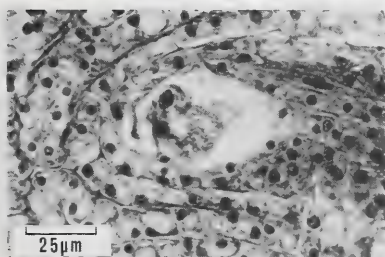
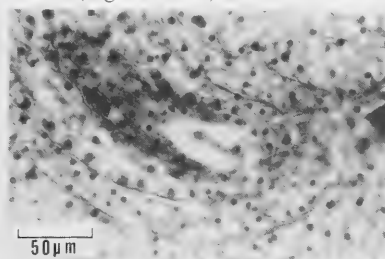


FIG. 9.

A longitudinal section through the ovule showing a binucleate embryo-sac.

FIG. 10.

A longitudinal section of the four-nucleate embryo-sac of *E. caffra* showing (a) the chalazal and (b) the micropylar nuclei.

FIG. 11a.

Mature embryo-sac showing the primary endosperm nucleus (en) and the synergids (syn).

FIG. 11b.

Mature embryo-sac showing the egg cell (e) and the primary endosperm nucleus (en).

In *E. caffra* the embryo-sac development is monosporic and follows the pattern of the *Polygonum*-type. Megasporogenesis and the development of the embryo-sac correspond to the findings reported for *E. indica* (Chandravadana, 1963).

Organization of the mature embryo-sac

Each of the synergids of *E. caffra* has a large vacuole at its chalazal end and a nucleus at the micropylar end (Fig. 11a). No hooks or filiform apparatus are present. In *E. indica*, however, the synergids do possess hooks (Chandravadana, 1963). Their degeneration occurs before fertilization.

The antipodals are typically triangular in shape and these, too, are ephemeral, degenerating before the synergids. Within the embryo-sac and concentrated round the primary endosperm nucleus is cytoplasm with an exceptionally granular appearance, which suggests the presence of starch grains.

In general the results of this study are in accordance with those previously published for legumes and, in particular, for *E. indica* (Chandravadana, 1963).

ACKNOWLEDGEMENTS

This paper forms part of a project which was financially supported by the C.S.I.R., Pretoria and the University of Port Elizabeth.

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